Psephis tellimyalis Cpr. B. A. Rep. Moll. Western N. Am., p. 641, 1864; Journ. de Conchyl. xii, p. 135, 1865 (larval shell).

This species belongs to the middle American or Panamic fauna and is known to extend as far north as San Pedro and south to the Peruvian coast. The *P. cognata* is somewhat more restricted and seems most abundant in the Gulf of California. It has been found as far north as San Diego. The *P. nivea* (*Mytilus niveus* Chemn.) Gmelin, is an Indo-Pacific species, very similar to *P. denticulata* and confounded with it by most of the early writers.

DESCRIPTION OF A NEW CALIFORNIAN LAND SHELL.

BY F. W. BRYANT.

Epiphragmophora Bowersi, n. sp.

Shell umbilicated, convex; epidermis olivaceous; spire slightly elevated; whorls between 4 and 5, convex, gradually increasing; suture well defined; aperture transverse, nearly circular; peristome whitish, thin, very slightly expanded at the basal portion, at the columella broadly reflected, yet leaving the umbilicus entirely open, showing within the whorls to the apex; base convex.

A well-defined, moderately broad, light-chestnut band revolves above the centre of the body whorl, and is visible above the suture on the whorl preceding the last; lines of growth close and distinctly marked.

Greater diameter 13, lesser 10, height 6 mm.

Location, San Jacinto Mts., Riverside County, California.

THE CORROSION OF SHELLS IN CABINETS.[1]

The above is the title of a paper of the greatest importance to all collectors of shells, and especially to those having charge of museums where the shells are usually glued to cards or tablets. Although no corrosion of shells has been noticed in the collections of this country, it is well to be on the lookout, and to guard against all apparent causes.

[1] The Corrosion of Shells in Cabinets. By L. St. G. Byne, M. Sc. With a prefatory note by T. Cosmo Melvill, M. A., F. L. S. The Journal of Conchology, Vol. ix., pp. 172–178, and pp. 253–254, 1899.

Mr. Melvill says: I first noticed the deterioration of a *Mitra* (*Zierliana*) *ziervogeliana* in our National Collection, now many years ago, and a year or two afterwards the disease had spread to another example on the same tablet. I have never had any specimens in my own collection thus attacked, excepting one, and that I fancy must have come into my possession diseased, and it was forthwith destroyed. But none of these are glued or affixed in any way to tablets, as is the case in most museums, but are either placed loose on cotton wool, or in glass-topped boxes. I may add that I have seen too frequently in the almost hermetically-sealed drawers under the cases in the British Museum a dulness first pervading the exterior of certain *smooth* species more markedly *e. g.*, Conus, Cypræa, and especially Naticidæ. Then grey acid efflorescence, both tasting and smelling strongly of vinegar, covers the whole surface like a powder, rising doubtless from the interior, and the specimens are soon almost irretrievably ruined. This evil being, therefore, of most serious significance, the sooner one is able to cope with it satisfactorily the better, and I am sure our best thanks are due to Mr. Byne for having been the first to take the matter in hand.

From Mr. Byne's exhaustive paper we extract the following:

"The shells which formed the subject of my experiments were from the National Collection at South Kensington, furnished me through the courtesy and kindness of Mr. E. A. Smith. These alone are referred to unless where otherwise distinctly stated. The shells in the cabinet drawers are in many instances either partially or entirely destroyed, the surface being corroded and covered with a fine white powder substance, which can be easily scraped off with a knife. This caused them to resemble Eocene mollusca.

Many species are quite unrecognizable on account of the surface being eaten away so deeply. The destruction has traveled from shell to shell and drawer to drawer, like a disease, several valuable specimens being spoilt.

The mischief has assumed large proportions, and being still on the increase causes the greatest anxiety.

The most remarkable facts are—

1. Only marine species are attacked.

2. Highly polished shells, such as those of Cypræa, are the most liable to be affected.

3. It does not extend to every specimen in a drawer, and of several mounted on the same tablet, perhaps one only is attacked.

4. Loose shells are also destroyed, but there are comparatively few of these compared with the number of those mounted on cards.

5. The shells affected are from twenty to fifty years old, but the corrosion does not appear until after the lapse of about ten years. The process is thus an extremely slow one.

6. It occurs principally amongst the shells kept in drawers in the dark, where the air is confined and seldom changed.

7. If the tongue be placed against one of the shells, an astringent alum-like taste will be observed.

We now come to the consideration of possible causes of corrosion. They appear to me to be four in number.

I. *Damp.*—If the shells were placed in a room or gallery that was not properly warmed, a very probable reason would be that a fungus had been formed, eating away the surface of the shell. The shell gallery of the Natural History Museum is, I am assured, excessively dry. This cause is, therefore, excluded.

II. *The action of sulphuric acid.*—It is well known that the atmosphere of cities contains free sulphuric acid (in addition to other sulphur compounds) derived from household fires and the burning of coal-gas. This acting over a period of years would slowly eat away the calcium carbonate of the shell, forming calcium sulphate. If this were the explanation, then the whole of the white powdery substance on the surface of the shell would consist of calcium sulphate. Analysis, however, showed that none was present.

III. *Presence of salt.*—Shells that had not been soaked in fresh water before being placed in the cabinets would contain salt, not only in the epidermis, but also held mechanically amongst the particles of calcium carbonate. It is highly probable that its presence would exert a deleterious influence.

Chemical tests showed that it was practically absent in the shells examined, a fact that occasioned some surprise.

IV. *Action of an acid substance.*—After carefully considering all the facts in my possession, I have come to the conclusion that the corrosion is due to the action of butyric acid.

Upon opening the box of shells sent me by Mr. E. A. Smith, I at once noticed a pungent vinegar-like odor, which pervaded the fingers and everything that came in contact with them. This pointed to the presence of acids of the acetic series. Analysis showed that every shell contained butyric acid, as calcium butyrate. A few contained

calcium acetate. Butyric acid is a product of the fermentation of animal matter, and its original source was found in the following manner; A specimen of *Strombus tricornis* was soaked in distilled water for a week. A piece about the size of a pea, of a grayish gelatinous substance was found at the bottom of the glass vessel. This had come from the interior of the shell, and chemical tests showed it to be organic matter. The shell had probably been more than twenty years in the Museum.

This at once furnished the explanation which I now bring forward, namely: That the pieces of the animal left in the shell, through insufficient cleaning or otherwise, ferment, setting free butyric acid. This substance is extremely volatile, and pervades the whole of the drawers and cabinets. The amount present can only be extremely small, but acting as it does for so many years, it slowly eats away the surface to a considerable extent, converting the calcium carbonate into calcium butyrate.

The reason that land and fresh-water species are not attacked is that their epidermis acts, so to speak, as a coat of mail. Hence, highly-polished species of Cypræa, etc., are the most liable to corrosion through lack of such protection.

The fact that the shells exposed to daily public inspection in the top cases are less attacked is explained on the hypothesis that the light acts as a deterrent. I have also come to the conclusion that the gum used in attaching the shells to the tablets has something to do with the corrosion. The majority of the shells affected in the National Collection are gummed to tablets. As far as can be ascertained, the corrosion has never occurred in private collections where the shells are and always have been loose. The gum ferments, acetic acid being formed. This eats away the calcium carbonate, forming calcium acetate; this latter substance was found in several of the shells examined, in addition to the calcium butyrate.

V. *Prevention.*—In the case of those shells which are badly affected, nothing can be done, and their instant removal is absolutely essential, for if left, they only increase the mischief with those just beginning to show signs of corrosion. I recommend that they be soaked for twenty-four hours in a solution of corrosive sublimate (1 part in 1,000 water) and then thoroughly dried.

As an experiment, all shells should be subjected to such treatment, in the hope that it may prove effectual. It is quite impossible to say

beforehand whether this will be an infallible remedy. Time only can prove its efficacy.

On page 235 of the same volume Mr. Byne gives the following supplementary notes to his former observations:

"At the time of writing my former paper I did not possess any knowledge of bacteriology, but I had come to the conclusion some months before that the corrosion was due originally to the action of bacteria. I am now enabled, through the kindness of Dr. Ewart, to adduce a considerable amount of evidence in support of this. I still adhere to the five items of my previous summary.

The white powdery substance upon the surface of the shells was found to consist of calcium butyrate, in some instances mixed with calcium acetate. It was formed by the action of butyric and acetic acids upon the calcium carbonate of the shell structure.

Since butyric acid does not occur in the atmosphere, it can hardly have had an external origin. It must, therefore, have been derived from fermentative processes occurring in the organic material of the shell, or of adhering portions of the molluscan inhabitant. Both aërobic and anaërobic bacteria are known which can cause various carbohydrates to ferment, producing butyric and acetic acids. It is very often the case that a portion of the liver is left attached to the shell, especially to the apex. This might easily undergo butyric fermentation, and, moreover, the same might occur with the adhesive substance used to fix the specimen to its card. Both aërobic and anaërobic butyric bacteria exist, but the common forms are anaërobic. Hence we should expect to find the danger of spoiling increased with imperfect aëration in closed or hermetically sealed cases, in which at the same time there would be no possibility of the acid products escaping. A little moisture is required to start the fermentation; hence, dry cases should escape, and even in damp air the process can only take place with great slowness, for so soon as the products accumulate to a certain extent, fermentation ceases until they have been removed.

That the mischief is of bacterial origin is supported by the following facts:

1. *Butyric acid has been found.*

This could only be produced by the butyric fermentation of carbohydrates, or even proteid substances. Acetic acid is amongst the fermentative products of butyric bacteria, and calcium acetate has been found in some of the shells.

2. *The shells in the top cases that are exposed to light are practically unaffected.*

This points strongly to bacteria. The deadly action of direct sunlight on bacteria is well known, and may produce death in from five minutes to an hour when they are in the vegetative condition. Even strong diffuse daylight suffices to retard or even inhibit the development of many bacteria.

3. *The shells in the drawers kept in the dark are the worst attacked.*

This necessarily follows from the above statement. Darkness is favorable to the development of these fermentative organisms. Within the shell the bacteria would even in the top cases be protected from the inimical effect of light.

I stated in my former paper that the corrosion had not occurred in private collections. Since its publication I have been informed that some shells in a large private collection at Birmingham have been badly corroded, and have caused anxiety for some time past.

PREVENTION.

It must surely be conceded that an infallible remedy cannot be given. My critics have either overlooked or paid no attention to the fact that the corrosion does not appear until after the lapse of about ten years.

The suggestions received are:

1. Boiling in oil.

2. Rubbing over the surface with such substances as oil of turpentine oil of cloves, and formalin.

I am of the opinion that these may be dismissed as ineffectual. Now that we know that the corrosion is caused by bacteria, I am more than ever convinced that soaking in corrosive sublimate solution, combined with previous thorough cleaning, will prove effectual. It must be remembered that corrosive sublimate is an *extremely poisonous* substance. The drawers should be thoroughly aërated at intervals, to remove accumulated acid vapors, which will never be present in more than minute traces.

The drawers should also be kept well dried.